Distribution of the millipede genus *Apheloria* Chamberlin, 1921; summaries of peripheral localities and ones of *A. virginiensis* (Drury, 1770) west of the Mississippi River (Polydesmida: Xystodesmidae)

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The xystodesmid milliped genus Apheloria Chamberlin, 1921, is the 2nd-most widely ranging North American genus in the family (after Pleuroloma Rafinesque, 1820) and the 5th overall among North American diplopods (after Oriulus Chamberlin, 1940 [Julida: Parajulidae]; Narceus Rafinesque, 1820 [Spirobolida: Spirobolidae]; Pleuroloma; and Scytonotus C.L. Koch, 1847 [Polydesmida: Polydesmidae]) (Keeton 1960, Shelley 1980, 1993, 2004, 2005, 2006). It occupies a broad area between the Central Plains and the Atlantic Ocean that lies generally north of the Gulf Coastal states and extends northward into southern Québec, eastward into western New England, and southward to the southern extremity of the Ouachita Physiographic Province in Oklahoma (Fig. 1; Causey 1954, Shelley 1988, 2002, Snider 1991, Hoffman 1999, McAllister et al. 2002, 2003; plus unpublished records in the ensuing repositories and records cited on the INHS web page [acronyms below]). Apheloria is 1 of only 2 unrevised xystodesmid genera in eastern North America, the other being Nannaria Chamberlin, 1918; however, both were addressed synoptically by Hoffman (1999). According to this treatment, Apheloria comprises 3 species: A. virginiensis (Drury, 1770), which is divided into 5 subspecies and occurs throughout the generic range except for the southeast; A. montana (Bollman, 1887), in the southern Appalachian Mountains and Cumberland Plateau from Kentucky and Virginia to Georgia and Alabama; and A. tigana Chamberlin, 1939, extending from the Blue Ridge Province in southern Virginia to southeastern North Carolina. The species of Apheloria are colorful, relatively large-bodied xystodesmids with primarily yellow paranota and either yellow to pinkish transverse bands along the caudal metatgal margins, or discrete, yellow middorsal spots or semilunar splotches (Shelley 1978: figs. 62–63; Whitehead and Shelley 1992: figs. 2–3); a color photo of A. montana, with yellow middorsal spots, from Oak Ridge, Anderson Co., Tennessee, adorns the cover of the March 1967 (vol. 17[3]) issue of Bioscience. As sympatric xystodesmids display the same or

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similar colors and patterns, *Apheloria* can be recognized by the diagnostic circular or “sickle-shaped” gonopods (Attems 1938: fig. 186; Chamberlin 1939: figs. 29–31, 33–35; Chamberlin 1947: fig. 8; Hoffman 1949: figs. 1–2; Hoffman 1978: figs. 1, 3; Shelley 1978: figs. 65–66; Shelley 1988: fig. 34).

As with most Atlantic Coastal milliped taxa that traverse the Mississippi River, few published records of *A. virginiensis* exist from west of this watercourse. Hoffman (1999) recognized 2 “western” subspecies, both authored by Chamberlin (1939): *A. v. iowa*, which spans the river and occurs in eastern Iowa and western Illinois, and *A. v. reducta*, in the Ozark and Ouachita Plateaus of Arkansas and Missouri; the latter subspecies was also documented from the Ouachita Province in McCurtain Co., Oklahoma, by Causey (1954). Hoffman suggested that the taxa likely merge and that there may be only 1 “western” subspecies, but he did not synonymize the names and both presently stand; they occur on opposite sides of the Missouri River, which may divide their ranges.

The 1st published citations of *Apheloria* from west of the Mississippi River were by Chamberlin (1939) in the descriptions of *A. iowa* from Mt. Pleasant, Henry Co., Iowa (Fig 2, triangle), and *A. reducta* from Imbolben,
Lawrence Co., Arkansas (Fig. 2, star). Causey (1952) reported *A. reducta* from Barry Co., Missouri, and 14 Arkansas counties that were subsequently referenced generally by Chamberlin and Hoffman (1958); 2 years later, she (Causey 1954) reported the milliped from an unspecified site in McCurtain Co., Oklahoma. After Chamberlin and Hoffman’s summary, 28 years passed before more “western” localities were cited of *A. corrugata* (Wood, 1864), from caves and a spring in 4 counties in Missouri (Gardner 1986). Hoffman (1999) reduced *iowa* and *reducta* to subspecific statuses under *A. virginiensis* and provided the aforementioned range summaries, though overlooking Causey’s record (1954) from Oklahoma. McAllister et al. (2002) reported *A. v. reducta* from 2 localities in McCurtain Co., thereby confirming Causey’s citation from the county in general. The same authors (McAllister et al. 2003) subsequently recorded the milliped from 23 ostensibly new Arkansas counties, 12 of which had been cited by Causey (1952) in a reference they missed.

In addition to these taxa, *Fontaria luminosa* Kenyon, 1893, potentially applies to 1 or both races, but its identity has never been unequivocally established. Kenyon (1893) proposed the binomial for a male and female from Omaha, Douglas Co., Nebraska, that purportedly had also been seen at Lincoln, Lancaster Co.; however, the latter city, located in the eastern Great Plains and removed from riparian habitats along the Missouri River at Omaha, seems implausible and is discounted herein. According to Kenyon, the gonopods consisted of a “long basal piece from which a small flattened process curves inward, forward, outward, and downward,” a reasonable characterization of a circular structure by a nonspecialist in that era. Dorsally, the millipeds were “yellowish brown” with “a narrow yellow line” above the margins of each segment and “round yellow marks” near the lateral edges, which we interpret as a yellow transverse band along the caudal margin of each metatergite and yellow paranotal spots. The latter were purported to be the source of an uncorroborated “whitish phosphorescence,” hence the specific name. Aside from the bioluminescent species of *Motyxia* in Tulare, Kern, and Los Angeles Cos., California (Shelley 1997), “phosphorescence” of any kind has not been reliably reported in a xystodesmid milliped. As noted by Shelley (1986), there is a xystodesmid sample from Omaha at the NMNH containing 1 male and 3 females with a label stating “Fontaria luminosa (Type?)” but the gonopods of the male are lost. Only 3 xystodesmids potentially occur at Omaha: *P. flavipes, A. virginiensis,* and *Semi-onellus placidus* (Wood, 1864); the millipeds in this sample are much too large and robust to be the last, and they lack the broad sternal lobes that diagnose *P. flavipes* (Shelley 1980, 1994). *Apheloria virginiensis* is thus the only possibility for these specimens if they are indeed from Omaha and are the types of *F. luminosa*. Topotypes are therefore necessary to resolve these questions, but RMS and our
colleague R.L. Hoffman have searched for \textit{A. virginiensis} in riparian forests along the Missouri River near Omaha without success; for the purposes of this contribution, we assume this occurrence. Hoffman (1999) therefore listed “\textit{Apheloria luminosa} (Kenyon)” as a species of uncertain status until occurrence at or near Omaha is confirmed. He suggested that \textit{luminosa} may be a senior name for \textit{A. iowa}, whose type localities are at essentially the same latitude and considerably north of the northernmost records of \textit{A. v. reducta}, in Cole, Franklin, and St. Louis Cos., Missouri, south of the Missouri River (Fig. 2). However, we note that all records of both \textit{A. v. reducta} and \textit{F. luminosa} are on the same, western/southern, side of this watercourse, and the Nebraska records, if truly referring to \textit{Apheloria}, could represent a northern population of \textit{A. v. reducta}. \textit{Fontaria luminosa} could therefore be a senior name for either \textit{reducta} or \textit{iowa}, so topotypical specimens are essential.

On 4 May 2005, CTM collected an adult male of \textit{A. v. reducta} in the southeastern corner of Cherokee Co., Kansas, constituting the 1st record of the genus, species, and subspecies from the state. The site is about 2 mi (3.2 km) west of the Missouri state line and 5 mi (8 km) north of Oklahoma, and is in the Ozark Plateau Physiographic Province that extends only about 5 mi (8 km) into this corner of Kansas to the town of Baxter Springs. The millipede is black with yellow, triangular paratal markings that continue slightly mediad along the caudal metatergal margins but do not extend into distinct transverse bands, although there are faint, narrow bands on segments 15–19. There is no band on the collum, and the epiproct is black basally and yellow apically. The specimen was encountered in typical upland Ozarkian habitat, beneath a partly buried oak log near a spring in the vicinity of Shoal Creek; the closest published record is that of Causye (1952) from an unspecified site in Barry Co., Missouri, which lies approximately 40 mi (64 km) to the southeast. We report here the Kansas locality along with unpublished localities from Missouri, Arkansas, and Oklahoma; we summarize the published records; and we map all the sites, thereby fully documenting the “western” occurrences of \textit{A. virginiensis} (Fig. 2). As the generic range has never been documented, we also report new records from east of the Mississippi, emphasize peripheral localities, project occurrences in all occupied US states and Canadian provinces, and map the projected distribution (Fig. 1). We provide complete citations for “eastern” states with 5 or fewer new counties and the states for counties with 6 or more; general citations are referenced when specific localities are not available. Missing data from the new records were not provided on the vial labels, and open symbols in fig. 2 represent projected occurrences in Iowa and Missouri that are directly opposite known sites east of the Mississippi River.

Repository acronyms are as follows: AMNH–American Museum of Natural History, New York; BMNH–Natural History Museum, London; BYU–Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah; CMNH–Carnegie Museum of Natural History, Pittsburgh, Pennsylvania; CLMNH–Cleveland Museum of Natural History, Cleveland, Ohio; CTM–private collection of C.T. McAllister; DMNH–Dayton Museum of Natural History, Dayton, Ohio; EIL–Biology Department, Eastern Illinois University, Charleston; FMNH–Field Museum of Natural History, Chicago, Illinois; FSCA–Florida State Collection of Arthropods, Gainesville; HUD–Hudsonia Environmental Research Institute, Bard College, Annandale, New York; INHS–Illinois Natural History Survey, Champaign; JAB–private collection of J.A. Beatty, Carbondale, Illinois; LSU–Museum of Zoology, Louisiana State University, Baton Rouge; MCZ–Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; MEM–Mississippi Entomological Museum, Mississippi State University, Starkville; MHNG–Muséum d’Histoire Naturelle, Geneva, Switzerland; MPM–Milwaukee Public Museum, Milwaukee, Wisconsin; NCSM–North Carolina State Museum of Natural Sciences, Raleigh; NMNH–National Museum of Natural History, Smithsonian Institution, Washington, DC; OKSU–Entomology Department, Oklahoma State University, Stillwater; OMNH–Sam Noble Oklahoma Museum of Natural History, Norman; PMNH–Peabody Museum of Natural History, Yale University, New Haven, Connecticut; PSU–Entomology Department, Pennsylvania State University, State College; SIU–Biology Department, Southern Illinois University, Carbondale; TMM–Texas Memorial Museum, University of Texas, Austin; UAAM–University of

Published Range Statements and Records

Eastern North America from Vermont and southern Ontario south to North Carolina, Tennessee, and Arkansas, northwest to eastern Iowa (Chamberlin and Hoffman 1958). New England to Georgia in the mountains, and westward as far as Oklahoma and Iowa, represented in the Central Lowlands and Atlantic Coastal Plain as well as in the Appalachian region (Hoffman 1978). The northern two-thirds of eastern North America from a line extending from central New York through southern Ontario, southern Wisconsin, and northern Iowa south to central Arkansas, northern Alabama, and northern South Carolina; longitudinally from along the Atlantic Ocean from southeastern North Carolina to central Connecticut west to eastern Oklahoma and southeastern Nebraska (Shelley 1986). Northeastern and central United States (Hoffman 1999).

Canada


United States of America

NEW HAMPSHIRE: New Hampshire in general (Kevan 1983).

VERMONT: Vermont in general (Kevan 1983).

MASSACHUSETTS: Massachusetts in general (Chamberlin and Hoffman 1958, Kevan 1983).

CONNECTICUT: Central Connecticut (Shelley 1986).


MARYLAND: Garrett Co. (Chamberlin 1947).

WEST VIRGINIA: Pendleton Co. (Causey 1955).


South Carolina: Northern South Carolina (Shelley 1986).

Georgia: Northern Georgia (Hoffman 1999).


Ohio: Abundant in southeast, rare in north (Williams and Hefner 1928). Gallia Co. (Morse 1902).

Indiana: Southern Indiana (Chamberlin and Hoffman 1958). Benton, Crawford, Franklin,


**Wisconsin**: Southern Wisconsin (Shelley 1986).


**Oklahoma**: Eastern Oklahoma (Shelley 1986). McCurtain Co. (Causey 1954), Beavers Bend St. Pk. and Broken Bow (McAllister et al. 2002).

**Nebraska**: Southeastern Nebraska (Shelley 1986). Douglas and Lancaster Cos. (Kenyon 1893 [questionable records based on “Fontaria luminosa”], Shelley 1986).

**South Dakota**: Southeastern South Dakota along the Missouri River (Shelley 1986, predicted occurrence yet to be verified).

**Deletions**

New Hampshire; Lincoln, Lancaster Co., Nebraska. While the xystodesmid Signoria (Rudiloria) trimaculata trimaculata (Wood, 1864) occurs in New Hampshire (Shelley 1996), Apheloria has never been collected there, nor is any part of the state encompassed by the projected range (Fig. 1). Kenyon’s (1893) record of *F. luminosa* from Lincoln, which is on the Central Plains and removed from riparian, riverine habitats with deciduous leaf litter, is implausible for Apheloria.

**Projected Occurrences and New Records**

**Canada**


**United States of America**

**Vermont**: No definite records but anticipated in the western/southwestern one-third of the state.


**New Jersey**: Northern half of the state north of the “neck” extending from Trenton to Raritan Bay. Bergen Co., Englewood, ②, 22
June 1907, G. von Krokow (UMMZ); Palisades, δ, 7 September 1908, W.J. Gertsch (AMNH); Mahwah, δ, 2♀, 11 May 1941, W.J. Gertsch (AMNH); and Ramsey, δ, 10 June 1944, W.J. Gertsch (AMNH). Essex Co., Short Hills, 3♀, 13 June 1908 (AMNH); and East Orange, δ, ♀, 10 July 1910, R.V. Chamberlin (NMNH). Morris Co., Newfoundland, δ, 28 May 1910, H.J. Lutz (AMNH). Southermost locality: Union Co., Somerset, nr. Plainfield, δ, 23 May 1909, A.W. Millar (AMNH). New state record.


Delaware: Unknown from the state but expected in the northern extremity west of Wilmington and north of Highway I-95.


District of Columbia: Districtwide. Rock Creek Park, δ, 6 April 1905, O.F. Cook (VMNH); and near Potomac R. just above Washington, δ, 8 April 1910, O.F. Cook (NMNH). New record.


SOUTH CAROLINA: The northeastern and north central border region, represented by 3 records in the northeastern Piedmont and a Coastal Plain site approximately 100 mi (160 km) eastward on the “Grand Strand.” Chesterfield Co., Cheraw, ?, 3 July 1958, K. Dawson (FSCA); 4 mi (6.4 km) N Chesterfield, along SC Hwy. 145, 3♂, 4♀, 12 July 1979, R.M. Shelley, R.K. Tardell (NCSM); and along SC Hwy. 9, 0.4 mi (0.6 km) E Lynches Rd., 3♂, 2♀, 12 July 1979, R.M. Shelley, R.K. Tardell (NCSM).


Atlantic Coastal locality and southeasternmost generic record: Georgetown Co., Brookgreen Gardens, along U.S. Hwy. 17 ca. 2 mi (3.2 km) N Litchfield Beach, 3♂, 2♀, 14 June 1971, M. Kosztarab (VMNH). First state localities.


TENNESSEE: Expected statewide except the southwestern corner and the counties bordering Mississippi. Anderson, Blount, Campbell, Claiborne, DeKalb, Dickson, Greene, Grundy, Johnson, Hancock, Loudon, Macon, Maury, McMinn, Monroe, Morgan, Obion, Overton, Polk, Putnam, Robertson, Scott, Sevier, Smith, Sullivan, Van Buren, Washington, Wayne, and Wilson Cos. (FSCA, INHS, LSU, MCZ, NCSM, TMM, UMMZ, VMNH).


INDIANA: Statewide. Dearborn, Jefferson, Lawrence, Morgan, Owen, Parke, and Porter Cos. (FSCA, INHS, VMNH).


IOWA: Distribution unknown with only 1 record; projected as the southeastern third of the state, extending northward in the east along the Mississippi River.


ARKANSAS: Northeastern periphery and the northwestern half of the state from south of the “heel” of Missouri southwestward to the southern border of the Ouachita Physiographic Province in Polk Co. Baxter Co., 5 mi (8 km) E Big Flat, 3♂, 30 July 1955, L. Hubricht (MHNNG). Conway Co., Petit Jean St. Pk., 3♂, 6 August 1955, L. Hubricht (MHNNG); and southern edge Petit Jean St. Pk. along AR Hwy. 155,


Easternmost locality in Ouachita Physiographic Province: Conway Co., 5 mi (8 km) N St. Vincent (McAllister et al. 2003).


Kansas: Projected for the Missouri River floodplain north of Kansas City and the extreme southeastern corner, but only 1 record. Cherokee Co., 1 mi (1.6 km) S Galena, Schermerhorn Park on KS Hwy. 26, 4 May 2005, C.T. McAllister (NCSM). New state record.

Nebraska: Riparian eastern fringe along the Missouri River; no new or definite records.

Discussion

These constitute a limited number of “western” records except for the Ozark and Ouachita regions of Arkansas, and substantial field collecting is needed to fully document the distribution in this part of the generic range. The type locality of A. iowa (Fig. 2, triangle) is the only record from Iowa, so the actual distribution here and whether A. v. reducta links with “F. luminosa” in Nebraska are unknown. However, the millipede can be reasonably expected in Jackson, Clinton, Scott, and Des Moines Cos., on the Mississippi River directly opposite Carroll, Rock Island, and Warren Cos., Illinois, where it does occur (samples in the INHS and VMNH); A. v. reducta can also be anticipated in Scott Co. and the “heel” (New Madrid and Peniscott Cos.) of Missouri, which are across the Mississippi from the Reelfoot Lake, Obion Co., Tennessee, locality (VMNH). The known distribution of A. v. reducta in Arkansas corresponds closely with highland areas in the Ozark and Ouachita Physiographic Provinces, which have been heavily sampled in contrast to lowland areas to the east; consequently, this correlation may be an artifact of sampling practices. The presence of A. v. reducta in southeastern Oklahoma suggests occurrence in neighboring northeastern Texas (Bowie Co. and adjacent counties), but the McCurtain Co. sites are on the border of the Ouachita Province and have substantial hardwood forests; south of Broken Bow, the habitat changes to essentially pure pine, which lacks the deciduous leaf litter that xystodesmids prefer. We therefore suspect that A. v. reducta is absent from the southeasternmost corner of McCurtain Co.; CTM and students have sampled in Bowie Co. and in northeastern Texas for 5 years without finding it. We have also worked substantially in the Coastal Plain Physiographic Province of southwestern Arkansas (Little River, Hempstead, Miller, Lafayette, and Columbia Cos.) and northwestern Louisiana (Caddo Parish) without encountering it, so we think the xystodesmid does not inhabit these areas. Thus, though Arkansas east of the Ouachitas has been poorly investigated, the millipede’s absence from the heavily sampled adjoining corners of Texas, Arkansas, and Louisiana suggests that its absence from Coastal Plain areas to the north may be real.

Overall, the projected distribution of Apheloria covers around 530–950 miles (848–1520 km) north–south, and 970–1190 miles (1552–1904 km) east–west (Fig. 1). The range spreads
farther north in the east and extends from southern Québec, Michigan, and Wisconsin to northeastern–north central South Carolina, northern Georgia and Alabama, and southeastern Oklahoma; east–west, it extends from the Connecticut River; metropolitan New York City, the western shore of Chesapeake Bay, Bald Head Island, North Carolina, and the “Grand Strand” of South Carolina to Mayes Co., Oklahoma, and, presumably, the western floodplain of the Missouri River in eastern Nebraska. It encompasses parts of 2 Canadian provinces and 27 U.S. states plus the District of Columbia, including all of Pennsylvania, West Virginia, Kentucky, Ohio, Indiana, and Illinois, all of New York except Long Island, all of Tennessee except the southwest, and all of Missouri except the Great Plains south of the Missouri River. Apheloria spans southern Lake Michigan, all of Lakes Erie and Ontario, and all or parts of such major rivers as the St. Lawrence, Hudson, Delaware, Potomac, York, James, Roanoke, Neuse, Cape Fear, Tennessee, Cumberland, New/Kanawha, Ohio, Wabash, Illinois, Mississippi, Missouri, Arkansas, and Canadian. The Connecticut and Tennessee rivers form apparent boundaries in the northeast / New England and Alabama, respectively, as does Chesapeake Bay in Maryland and Virginia. Apheloria occurs on 2 offshore islands / island groups—Bald Head, in the Atlantic Ocean off the southeastern corner of North Carolina, and the Thimbles, in Long Island Sound south of Stony Creek, Connecticut. Occurrence is projected for parts of Vermont and Delaware, but the genus is deleted from New Hampshire and the vicinity of Lincoln, Nebraska, which are areas incompatible with present knowledge. Mississippi lies wholly outside the distribution, as only the extreme northeastern corner (of Tishomingo Co.) bordering the Tennessee River is even plausible. The predicted occurrence of Apheloria along the Missouri River in southeastern South Dakota (Shelley 1986) was speculative but not unreasonable if it does inhabit riverine forests at Omaha, only around 90 mi (144 km) to the south. Below Vermillion, the southeastern corner of South Dakota extends southward between Iowa and Nebraska and the Big Sioux and Missouri rivers; this area has never been sampled for millipedes and warrants investigation for potential taxa like Pleuroloma, Narceus, and Auturus Chamberlin, 1942 (Polydesmida: Euryuridae), as well as Apheloria. Sampling is also needed in the projected range in Kansas, particularly along the Missouri River above Kansas City, and Iowa, to obtain more state records. The most urgent need, however, is an adult male from eastern Nebraska to confirm the assignment of F. luminosa to Apheloria (Shelley 1986, Hoffman 1999).

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